REMARKS

Claims 1-27 are pending in the present application.

In the office action mailed May 3, 2004 (the "Office Action"), claim 22 was rejected under 35 U.S.C. 102(e) as being anticipated by U.S. Patent No. 6,175,368 to Aleksic *et al.* (the "Aleksic patent"). Claims 1-9, 11, 13-15, 17-20, and 23-26 were also rejected under 35 U.S.C. 103(a) as being unpatentable over Blinn, "Simulation of Wrinkled Surfaces" (the "Blinn reference") in view of the Aleksic patent. Claims 10, 16, 21, and 27 were rejected under 35 U.S.C. 103(a) as being unpatentable over the Blinn reference in view of the Aleksic patent further in view of "Learning Alias Level One (the "Alias reference"). Claim 12 was rejected under 35 U.S.C. 103(a) as being unpatentable over the Blinn reference in view of the Aleksic patent further in view of Foley *et al.*, "Computer Graphics: Principles and Practice" (the "Foley reference").

The present invention includes embodiments of a gradient mapping engine that is used to calculate a perturbed normal vector N' for use in bump mapping applications. The perturbed normal vector N' can be defined by adding a displacement D to a normal vector N, that is, N' = N + D. Rather than calculate the displacement conventionally, the displacement is estimated using the following equation: $D = (f_u * P_v * scale_u) + (f_v * P_u *scale_v)$. Pu and Pv represent tangent vectors along the u and v axes, respectively, and f_u and f_v represent the derivative at a particular pixel having coordinates (u, v). The f_u and f_v values can be bilinearly filtered values obtained by iterating coordinates (bu, bv) of the bump map, which the gradient mapping engine receives from a triangle engine. The scaleu and scalev values are scalar values that are used to adjust the magnitude of the perturbed normal N'. Using the displacement estimation described above, a perturbed normal N' is determined.

The Blinn reference describes a method of modeling the appearance of surface irregularities through the use of a perturbed normal vector. A perturbed vector results from a normal vector displaced by a small perturbation vector. The perturbed vector is then used in calculating the color of the pixel. That is, rather than using the normal vector for shading calculations, the perturbed normal vector is used instead. As a result, the surface appears to have surface irregularities. As described in the Blinn reference, the perturbed normal vector is the sum of the normal vector and a displacement vector: N' = N + D, where D = (Fu (N x Pv) - Fv

(N x Pu), and where Fu and Fv represent the derivatives of the function F defining the surface irregularities with respect to u and v.

The Aleksic patent describes a system that provides bump mapping of an object with reduced overhead of conventional bump mapping techniques. Using bump map coordinates and physical display coordinates, two sets of bump intensity data are generated and stored in respective look-up tables ("LUTs"). Bump map coordinates are used by a coefficient determiner 22 to calculate first and second access coefficients. The first and second access coefficients are used as index values to access the LUTs to obtain first and second bump intensity values, 40 and 42, respectively. As described in the Aleksic patent, since the first and second axes of the bump map can be correlated to the fixed coordinates of the display space, the gradient intensities (fu · L) and (fv · L) can be calculated only once, rather than on a per-pixel basis.

Using the respective calculated gradient intensities, two sets of bump intensity values are calculated for a normalized range of axis coefficients B_u and B_v. The first bump intensity values are defined as $B_u \times (fu \cdot L)$ and the second bump intensity values are defined as $B_v \times (fv \cdot L)$. The plurality of pre-calculated bump intensity values $B_u \times (fu \cdot L)$ and $B_v \times (fv \cdot L)$ are stored in respective LUTs. Since the bump intensity values have already been calculated for normalized values of B_u and B_v, the specific B_u and B_v coefficients for a pixel are used as index values to access the sets of pre-calculated bump intensity values stored in the LUTs. The specifically selected bump intensity values $B_u \times (fu \cdot L)$ and $B_v \times (fv \cdot L)$ can then be summed to calculate a value representing the dot product of the bump vector ΔN and a light vector L. Thus, the operation of calculating bump intensity values merely involves a look-up operation and a summing operation. The bump intensity value (ΔN · L) 44 is in turn combined with a normal shading function (N · L) to obtain a resulting shading function (N + ΔN). Consequently, the resulting shading function is the sum of the bump intensity value and a normal shading function, or (N · L) + (ΔN · L).

Claim 22 has been rejected under 35 U.S.C. 102(e) as being anticipated by the Aleksic patent. Claim 22 recites a computer graphics processing system for calculating color values of pixels representing a surface, comprising a bump map filter having inputs at which bump map coordinates (bu, bv) are received, the bump map filter configured to iterate the bump map coordinates to generate first and second displacement components, a scale register storing first and second scale factors, and a gradient mapping circuit to calculate for each pixel a value

representative of a displacement vector having first and second perpendicular components, the first component equal to the product of a first vector tangent to the surface at the pixel, the first scale factor, and the first displacement component along the first vector, and the second component equal to the product of a second vector tangent to the surface at the pixel, the second scale factor, and the second displacement component along the second vector.

The Aleksic patent fails to teach the combination of limitations recited in claim 22. For example, the Aleksic patent fails to teach a computer graphics processing system having a bump map filter that iterates bump map coordinates to generate first and second displacement components or having a scale register storing first and second scale factors. Moreover, the Aleksic patent does not disclose a gradient mapping circuit calculating a displacement vector using the parameters recited in claim 22. The Aleksic patent, as previously discussed, teaches a system that can determine a shading function from the sum of a normal shading function $(N \cdot L)$ and a bump intensity value $(\Delta N \cdot L)$. As described in the Aleksic patent, the shadow function, which is ultimately the function trying to be obtained, is the dot product of a light vector L and the resulting (i.e., perturbed) vector, that is: shadow function $= L \cdot (N + \Delta N)$. The shadow function can be broken down into two components, a normal shading component $(N \cdot L)$ and a bump-shading component $(\Delta N \cdot L)$.

As explained in the Aleksic patent, the normal shading component can be calculated once for the particular object, and the bump-shading component is calculated through substitution of first and second bump intensity values selected from a plurality of values stored in respective LUTs. That is, the bump-shading component can be broken down as $(\Delta N \cdot L) = Bu\times(fu \cdot L) + Bv\times(fv \cdot L)$, where $Bu\times(fu \cdot L)$ is the first bump intensity value and $Bv\times(fv \cdot L)$ is the second bump intensity value for respective axes of the bump map. Each of the LUTs stores a plurality of respective bump intensity values which are selected by using axis coefficients Bu, Bv of respective axes of the bump map as indices. The plurality of bump intensity values stored in the respective LUTs represent the gradient values $(fu \cdot L)$ and $(fv \cdot L)$ for normalized Bu and Bv values. Thus, calculation of the bump-shading component $(\Delta N \cdot L)$ can be accomplished by accessing the two LUTs using the axis coefficients Bu, Bv to retrieve first and second bump-intensity values $Bu\times(fu \cdot L)$ and $Bv\times(fv \cdot L)$, and then summing the first and second bump intensity values.

The Aleksic patent does not describe the iteration of bump map coordinates by a bump map filter to generate first and second displacement components, or storing first and second scale factors in a scale register. Moreover, the Aleksic patent fails to disclose calculating a displacement vector using a gradient mapping circuit as recited in claim 22. The system described in the Aleksic patent never teaches calculating the perturbed normal, that is, using the notation of the Aleksic patent, $(N + \Delta N)$ is never actually calculated by the Aleksic system. The system described by the Aleksic patent avoids the need to calculate the perturbed normal vector entirely.

For the foregoing reasons, claim 22 is patentably distinct from the Aleksic patent, and therefore, the rejection of claim 22 under 35 U.S.C. 102(e) should be withdrawn.

As previously mentioned, claims 1-9, 11, 13-15, 17-20, and 23-26 have been rejected under 35 U.S.C. 103(a) as being unpatentable over the Blinn reference in view of the Aleksic patent.

Claim 1 is patentable over the Blinn reference in view of the Aleksic patent because the combined teachings fail to teach or suggest the combination of limitations recited by claim 1. Claim 1 recites a method of altering color values of a pixel along a surface function having an interpolated normal vector, comprising adding a displacement vector to the interpolated normal vector to produce a perturbed normal vector, the displacement vector calculated from the equation, D = (fu * Pu * scaleu) + (fv * Pv * scalev), where D is the displacement vector, Pu and Pv are perpendicular vectors tangent to the surface function at the pixel, fu and fv are displacement values along Pu and Pv, respectively, and scaleu and scalev are scaling values, and further iterating bump map coordinates (bu, bv) of texels to obtain the displacement values fu and fv, respectively, retrieving the scaling values scaleu and scalev from a scale register, and generating color values for the pixel based on the perturbed normal vector instead of the interpolated normal vector.

The Examiner has argued that the Blinn reference teaches adding a displacement vector to an interpolated normal vector to produce a perturbed normal vector, but fails to teach calculating a displacement vector using the equation: D = (fu * Pu * scaleu) + (fv * Pv * scalev). The Examiner cites the Aleksic patent as teaching the use of D = (fu * Pu * scaleu) + (fv * Pv * scalev) to calculate a displacement vector in order to make up for the deficiencies of the Blinn reference. As will be explained in more detail below, however, the Aleksic patent fails to make

up for the deficiencies of the Blinn reference. For example, the Aleksic patent fails to describe iterating bump map coordinates (bu, bv) of texels to obtain the displacement values fu and fv, respectively, retrieving the scaling values scaleu and scalev from a scale register, or calculating a displacement vector as recited in claim 1. The parameters to the equation described in the Aleksic patent are not the same as those recited in claim 1, and as a result, the equation described in the Aleksic patent cannot be the same. For example, the first and second bump intensity values $B_u \times (fu \cdot L)$ and $B_v \times (fv \cdot L)$ are calculated using a light vector L, a parameter that is not used in the calculation of the displacement vector as recited in claim 1. Moreover, a mere substitution of parameters into the equation described in the Aleksic patent will not result in calculating the displacement vector as recited in claim 1. The result of the equation described in the Aleksic patent is a bump intensity value. In contrast, the equation recited in claim 1 provides a displacement vector. Thus, the combined teachings of the Blinn reference and Aleksic patent fail to teach or suggest the combination of limitations recited by claim 1.

For the foregoing reasons, claim 1 is patentable over the Blinn reference in view of the Aleksic patent, and therefore, the rejection of claim 1 under 35 U.S.C. 103(a) should be withdrawn.

Claims 6, 11, 17, and 23 are also patentable over the Blinn reference in view of the Aleksic patent. The combined teachings of the Blinn reference and the Aleksic patent fail to teach or suggest the combination of limitations recited. For example, neither the Blinn reference or the Aleksic patent disclose iterating bump map coordinates (bu, bv) of texels to obtain the displacement values fu and fv, respectively. Additionally, retrieving the scaling values scaleu and scalev from a scale register, or calculating a displacement vector as recited in the respective claims, are not disclosed by either the Blinn reference or the Aleksic patent. As previously discussed with respect to claims 1 and 22, the Aleksic patent describes using bump map coordinates and physical display coordinates to generate two sets of bump intensity data and store the same in respective look-up tables ("LUTs"). Bump map coordinates are used by a coefficient determiner 22 to calculate first and second access coefficients. The first and second access coefficients are used as index values to access the LUTs to obtain first and second bump intensity values, 40 and 42, respectively. The equation described in the Aleksic patent does not use the same parameters as recited in the claims and is directed to solving a different value.

For the foregoing reasons, claims 6, 11, 17, and 23 are patentable over the Blinn reference in view of the Aleksic patent. Therefore, the rejection of claims 6, 11, 17, and 23 under 35 U.S.C. 103(a) should be withdrawn.

Claims 2-5, which depend from claim 1, claims 7-9 which depend from claim 6, claims 13-15, which depend from claim 11, claims 18-20, which depend from claim 17, and claims 24-26, which depend from claim 23, are similarly patentable over the Blinn reference in view of the Aleksic patent based on their dependency from a respective allowable base claim. That is, each of the dependent claims further narrows the scope of the claim from which it depends, and consequently, if a claim is dependent from an allowable base claim, the dependent claim is also allowable. For the foregoing reasons, the rejection of claims 7-9, 13-15, 18-20, and 24-26 under 35 U.S.C. 103(a) should be withdrawn.

As previously mentioned, claims 10, 16, 21, and 27 have been rejected under 35 U.S.C. 103(a) as being unpatentable over the Blinn reference in view of the Aleksic patent, and further in view of the Alias reference. Claim 12 has been rejected under 35 U.S.C. 103(a) as being unpatentable over the Blinn reference in view of the Aleksic patent, further in view of the Foley reference. Each of these claims depend from a respective allowable base claim, and are consequently patentable as well. Moreover, the Alias and Foley references fail to make up for the deficiencies of the combined teachings of the Blinn reference in view of the Aleksic patent, as previously discussed with respect to claims 1, 6, 11, 17, and 23. For the foregoing reasons, claims 10, 12, 16, 21, and 27 are patentable over the Blinn reference in view of the Aleksic patent, and further in view of the Alias and Foley references. Therefore, the rejection of claims 10, 12, 16, 21, and 27 under 35 U.S.C. 103(a) should be withdrawn.

All of the claims remaining in the application are now clearly allowable. Favorable consideration and a Notice of Allowance are earnestly solicited.

Respectfully submitted,

DORSEY & WHITNEY LLP

Kimton N. Eng
Registration No. 43,605
Telephone No. (206) 903-8718

KNE:ajs

Enclosures:
- Postcard
- Check
- Fee Transmittal Sheet (+ copy)
- Request for Continued Examination

DORSEY & WHITNEY LLP
1420 Fifth Avenue, Suite 3400
Seattle, Washington 98101-4010
(206) 903-8800 (telephone)
(206) 903-8820 (fax)

h:\ip\documents\clients\rendition\500497.01\500497.01 amend after final reject 1.116.doc